

STUDIES IN THE BIOLOGY OF THE LEECH.¹ VI.

THE ANATOMICAL BASIS FOR CERTAIN LEECH BEHAVIOR

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The behavior of an animal is the result of stimuli acting upon a particular arrangement of anatomical structures. In the leech a specific neuromuscular pattern is present. Motor neurons of this mechanism can be stimulated directly by direct current of low voltage. Miller (1934). The responses of the leech in an electrical field constitute the experimental basis upon which the probable arrangement of motor neurons enervating body wall muscles has been postulated. Miller (1936). The polarity of motor neurons is determined by the application of the "law of polar stimulation." Lillie (1923). The same technique has been successfully applied by Shensa and Barrows (1932) in their study of galvanotropic responses in the earthworm. The position and extent of the motor neurons in both the leech and the earthworm have been suggested by the resulting behavior of the organism. In every instance where the behavior of the organism involved only a few segments, it was apparent that motor neurons within the cord extended through several ganglia. In the present paper I propose certain anatomical features in support of the experimental evidence previously reported.

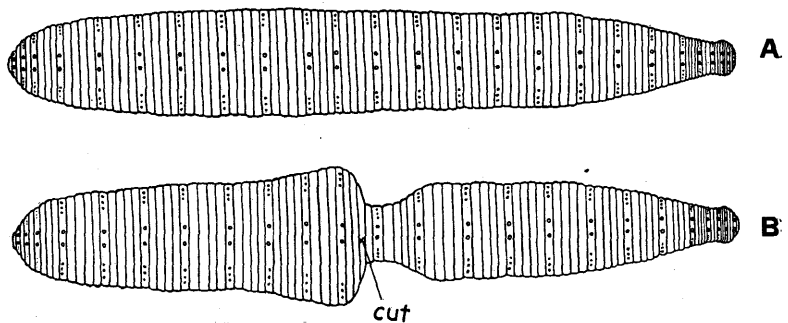


FIG. 1. A. The normal shape of the leech. B. The change in body form following nerve cord transection.

In a preceding paper of this series, Miller (1942), there was presented an account of the deviations in body form following nerve cord transection. Fig. 1. The specific reaction to which I was to refer is one occurring in the mid-body region following the transection of the ventral nerve cord. The operated leech showed in the region of the severed cord a constriction extending anteriorly, and an enlargement extending posteriorly. In the mid-body region a typical segment consists of five annuli. The affected area extended from three to five annuli anterior to the cut and from four to six annuli posterior to the cut. The area affected depended upon the relation of the cut to the segmental ganglia.

In the segment anterior to the cut, there was a loss of tone in the longitudinal muscles. Posterior to the cut there was a corresponding loss of tone in the circular

¹*Haemopsis marmoratis* (Say).

muscles. The minimum area affected embraces no less than two complete segments. From these observations it seemed reasonable to imply that motor neurons extended for short distances in the cord. According to Smallwood (1930) inter-

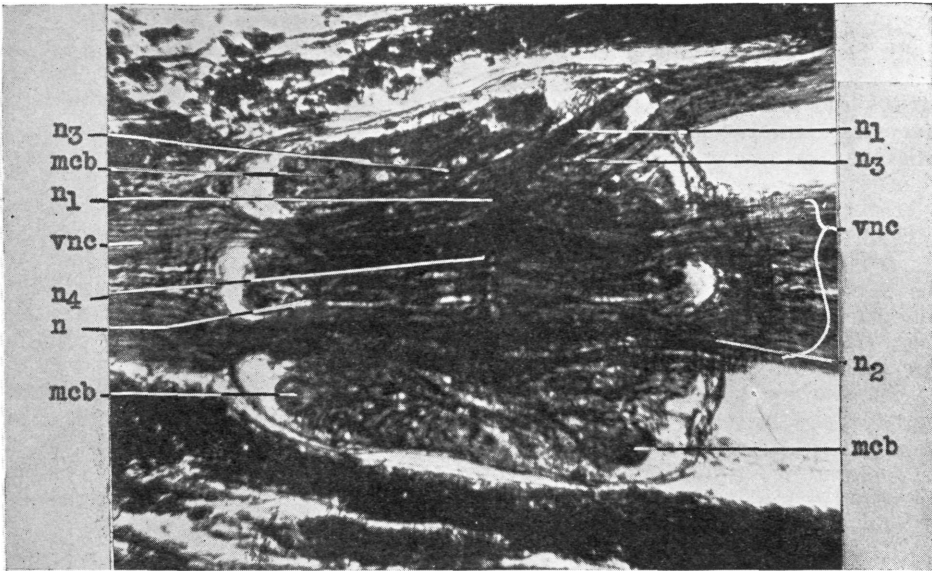


FIG. 2. Photomicrograph. A frontal section through a leech ganglion.

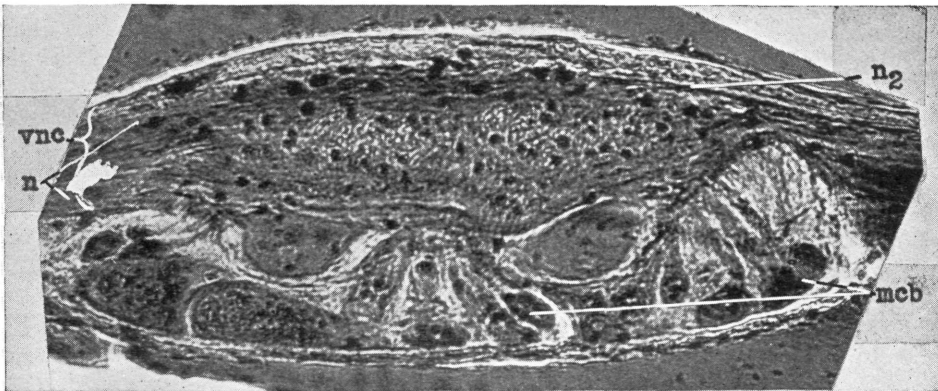


FIG. 3. Photomicrograph. A longitudinal section through a leech ganglion.

(v. n. c.) Ventral nerve cord. (n.) Interganglionic processes. (n₁) Interganglionic processes entering a lateral nerve. (n₂) Interganglionic processes continuing through the ganglion. (n₃) Motor axons entering immediate lateral nerve. (n₄) Motor axons extending into the ventral nerve cord. (m. c. b.) Motor cell bodies.

ganglionic neurons in the earthworm are small in size and few in numbers. Smallwood further states that these interganglionic nerve cells play but a small part in transmitting impulses from ganglion to ganglion. It is his contention that interganglionic correlation is the function of the giant fibers. Ogawa (1939), also

working with the earthworm, described numerous interganglionic nerve cells. Of the three types described, one which he calls "the gross cell" and which was previously mentioned by both Retzius and Krawany, is motor. This type of cell is described as passing over two or three adjacent ganglia. These are unipolar cells, the axon of which gives off numerous collaterals during its course.

In leech preparations, Figs. 2 and 3, using a special technique developed by the author, neurons similar to those described by Ogawa can be traced. In both frontal and lateral views interganglionic processes are visible. Certain of these processes enter the lateral nerves (n_1); others continue through the ganglion to adjacent segments (n_2). In passing through a ganglion, these long fibers occupy a position dorsal to the mass of nerve cell bodies. Fig. 3. In each ganglion large motor cell bodies are observed in well defined areas. Figs. 2 and 3. Several distinct types can be differentiated, among which are those whose axons enter the immediate lateral nerves (n_3), while others send their protoplasmic extensions into the nerve cord (n_4). This anatomical evidence substantiates the previous conclusions derived from experimental evidence, namely, that motor neurons extend short distances in the cord. It further offers an anatomical basis for understanding the segmental behavior following nerve cord transection.

The position of the nervous elements in the central system of the leech have, up to the present time, been determined almost entirely upon inferences drawn from experimental evidence. This is the first of a series of papers based on the neuro-anatomy of the leech and devoted to an analysis of the action systems, whereby the functional relationship of this mechanism can be applied to an understanding of the behavior of the organism.

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